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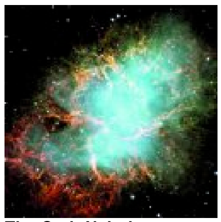
Bursting Beachballs

The explosive collapse of beachball-sized pockets of plasma creates nanosecond pulses in pulsar radio bursts.

by Pamela L. Gay

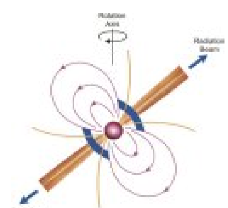


The Crab Nebula surrounds a pulsar that produces strong radio emissions.
ESO

Neutron stars are the dense coals of once-massive stars that have given up their atmospheres and collapsed into remnants so dense that protons and electrons are crushed together into neutrons. When neutron stars they can become pulsars — sending periodic blasts of radio emissions toward Earth when their magnetic poles are pointed in our direction. Recent observations using new high-speed detectors have allowed astronomers to discover subpulses within one pulsar's radio bursts. The extremely short duration of these subpulses indicates that they originate from regions no more then two feet across.

With the help of engineers from the National Radio Astronomy Observatory, a team of astronomers from the New Mexico Institute of Mining and Technology (New Mexico Tech) built specialized electronic equipment to study pulsars at very small timescales. The team used this equipment at the 1000-foot-diameter Arecibo radio telescope
to look for variations in the radio intensity of pulses from the Crab pulsar. Located in the heart of the Crab Nebula, this pulsar spins once every 33 seconds. It is one of three pulsars known to produce extra strong or "giant" pulses of radio emission interspersed among its normal pulses.

The researchers found that the Crab's "giant" pulses contain subpulses that each last no longer than two nanoseconds. Light travel time mandates that the region producing pulses this short can be no more than about two feet across.



This diagram shows how a pulsar beams its radiation.
NRAO

Before this study, three different theories were used to explain the radio pulses of spinning neutron stars. "The small size of these regions is inconsistent with all but one proposed theory for how the radio emission is generated," said team leader Tim Hankins.

He and his colleagues suspects that density waves in the plasma at the surface of the neutron star interact with their own electrical field, becoming progressively denser until they "collapse explosively," creating superstrong bursts of radio waves. The team presents its observations in the March 13 issue of *Nature*.

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